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	Subsystem/Office Calorimeter Subsystem	
Document Title **Calorimeter – LAT Interface Control Document**		

Gamma-ray Large Area Space Telescope (GLAST)

Large Area Telescope (LAT)

Interface Control Document between the Calorimeter Subsystem and LAT Instrument

DOCUMENT APPROVAL

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CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes

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1 PURPOSE

This document describes the sum total of interfaces of LAT to and from the Calorimeter subsystem of the LAT. It is intended to be used to delineate interfaces, so subsystems components can be designed and fabricated, based on clear, understood values for their interfaces to the rest of the LAT. This ICD will also serve as the requirements list against which interface tests are developed, and against which the CAL subsystem must be verified prior to integration on the LAT.

2 SCOPE

This ICD includes all interfaces of the CAL subsystem to other components of the LAT instrument.

3 DEFINITIONS

3.1 Acronyms

CAL	LAT calorimeter subsystem
FOV	Field of View
FWHM	Full Width Half Maximum
GLAST	Gamma-ray Large Area Space Telescope
IRD	Interface Requirements Document
LAT	Large Area Telescope
PSA	Power Supply Assembly
SI/SC IRD	Science Instrument – Spacecraft Interface Requirements Document
SRD	Science Requirements Document
TBR	To Be Resolved
TEM	Tower Electronics Module
TRG	L1 Trigger

3.2 Definitions

γ	Gamma Ray
μsec, μs	Microsecond, 10^{-6} second
A_{eff}	Effective Area
Analysis	A quantitative evaluation of a complete system and /or subsystems by review/analysis of collected data.
Arcmin	An arcmin is a measure of arc length. One arcmin is 1/60 degree.
Background Rejection	The ability of the instrument to distinguish gamma rays from charged particles.

Backsplash	Secondary particles and photons originating from very high-energy gamma-ray showers in the calorimeter giving unwanted ACD signals.
Beam Test	Test conducted with high energy particle beams
cm	centimeter
Cosmic Ray	Ionized atomic particles originating from space and ranging from a single proton up to an iron nucleus and beyond.
Dead Time	Time during which the instrument does not sense or record gamma ray events during normal operations.
Demonstration	To prove or show, usually without measurement of instrumentation, that the project/product complies with requirements by observation of results.
eV	Electron Volt
Field of View	Integral of effective area over solid angle divided by peak effective area.
GeV	Giga Electron Volts. 10^9 eV
Inspection	To examine visually or use simple physical measurement techniques to verify conformance to specified requirements.
MeV	Million Electron Volts, 10^6 eV
µsec, µs	Microsecond, 10^{-6} second
ph	photons
s, sec	seconds
Simulation	To examine through model analysis or modeling techniques to verify conformance to specified requirements
sr	steradian, A steradian is the solid (3D) angle formed when an area on the surface of a sphere is equal to the square of the radius of the sphere. There are 4 Pi steradians in a sphere.
Testing	A measurement to prove or show, usually with precision measurements or instrumentation, that the project/product complies with requirements.
Validation	Process used to assure the requirement set is complete and consistent, and that each requirement is achievable.
Verification	Process used to ensure that the selected solutions meet specified requirements and properly integrate with interfacing products.

4 INTRODUCTION

4.1 Subsystem Description

4.1.1 GLAST LAT Instrument

4.1.2 GLAST LAT Calorimeter

4.2 Applicable Documents

Documents that are relevant to the definition and functionality of CAL – LAT interfaces include the following:

GLAST00010, "GLAST Science Requirements Document", P.Michelson and N.Gehrels, eds., July 9, 1999.

LAT-SP-00010, "GLAST LAT Performance Specification", August 2000

LAT-SS-00018, "LAT CAL Subsystem Specification – Level III Specification", January 2001

LAT-SS-00210, "LAT CAL Subsystem Specification – Level IV Specification"

LAT-TD-00035, "LAT Coordinate System"

LAT-SS-00019, "LAT T&DF Subsystem Specification – Level III Specification"

LAT-SS-00115, "LAT Mechanical Subsystem Specification – Level III Specification"

4.3 Interface Description

4.3.1 General Description

The CAL-Grid interface is the primary mechanical interface for the CAL. This provides the structural support for the CAL, and provides a stable reference by which the CAL alignment is surveyed and maintained. This interface also provides the primary means by which heat generated in the CAL module is transferred out to the Radiators.

The CAL baseplate is the primary mechanical interface for the Tower Electronics Module (TEM) and Power Supply Assembly (PSA). This interface also provides the primary means by which heat generated in the TEM and PSA is transferred out to the Radiators.

The electrical interface for a CAL module is to the TEM and PSA subsytems mounted on the CAL module baseplate.

4.3.2 Calorimeter Responsibilities

Flight hardware: development, fabrication, and test of the following components: Calorimeter subsystem with mechanical, electrical and thermal characteristics identified in this ICD. In particular, CAL bottom plate with sufficient stiffness and strength, according to this ICD, and with tab details and features as described in the referenced drawing.
I&T MGSE: (TBR)
I&T EGSE: (TBR)

4.3.3 Mechanical Systems Responsibilities

Flight hardware: development, fabrication, and test of the following components: mounting bolts, washers, and threaded inserts for tab mounting. Also, procurement and installation of thermal contact tape at the interface.
I&T MGSE:

4.3.4 Electronics Responsibilities

Flight hardware: development, fabrication, and test of the following components: mounting bolts, washers, and threaded inserts for tab mounting. Also, procurement and installation of thermal contact tape at the interface.

I&T EGSE: TEM electrical and mechanical simulators for testing and operation of the CAL modules. Power Supply simulators to provide power to CAL modules.

5 GRID MECHANICAL INTERFACES

5.1 Coordinate System

The LAT coordinate system is defined in reference LAT-TD-00035

5.2 Dimensions

Stay-clear dimensions are not-to-exceed dimensions. The nominal dimensions plus any needed tolerances should be includes within this stay-clear. These dimensions are defined, and will be measured with respect to a unique datum reference system for each module. For Mechanical Systems, the datum reference is defined in TBD.

5.2.1 Nominal Stay-Clear Dimensions

All Mech System stay-clear and dimensions shall be quoted and measured with respect to the datum reference system defined in TBD, unless explicitly defined otherwise.

Mech System components shall stay within the stay-clear volume described in TBD. This volume includes the region for nominal dimensions and tolerances with respect to the datums desribed above.

5.2.2 Dynamic Stay-Clear for Dynamic Motions

During launch and on-orbit operation, dynamic motions due to external loading may cause parts of the Mechanical Systems to violate the static stay-clear dimensions. Maximum excursions beyond the static stay-clears delineated above are:

Lateral

Vertical

5.3 Mounting Configuration

5.3.1 Interface Location

5.3.2 Structural Mounting and Load Transfer

The Calorimeter mount to the Grid shall conform to the dimensions and tolerances shown in LAT-TBD. This describes the nominal dimensions and tolerances of the mounting tabs and holes on the CAL bottom plate.

The CAL bottom plate shall have the effective in-plane extensional stiffness of an aluminum plate, TBD mm thick in the mounting plane with the Grid

The CAL bottom plate shall have the effective in-plane shear stiffness of TBD in the mounting plane with the Grid.

The CAL bottom plate shall have a minimum effective bending stiffness of TBD

The CAL bottom plate shall have a CTE of 21-25 x 10^-6 m/m/degC

The CAL mounting tabs to the Grid shall be of a material and cleanliness such that the coefficient of static friction between the tabs and a plate of clean aluminum alloy is greater than 0.50 (TBR).

The Grid mounting surface for the CAL shall conform to the dimensions and tolerances shown in LAT-TBD. This describes the nominal dimensions and tolerances of the mounting surface on the Grid, holes and threaded holes.

The Grid webs shall provide a sufficiently rigid surface to prevent rotation of the CAL mounting tab.

The CAL shall be able to carry all loads associated with the electronics box when subjected to the launch environments described in section TBD, above. No further magnification or attenuation of loads is expected.

Tapped holes for mounting the electronics module to the CAL shall tolerate a maximum load plus pre-load of TBD newtons, without adverse affects on the threads or bolts.

5.3.3 Structural Interface Loads

The CAL shall be able to withstand launch static loads in the thrust axis of +3.25 g / -0.8 g at liftoff/transonic, and 6.0 +/- 0.6 g at MECO, without violating the dynamic stay-clears described in TBD. These loads are transmitted through the tabs on the CAL bottom plate.

The Grid shall be capable of tolerating the reaction forces due to CAL acceleration loading.

The CAL shall be able to withstand the launch static loads in both lateral axes of +/- 4.0 g at liftoff/transonic, and +/- 0.1 g at MECO, without violating the dynamic stay-clears described in TBD, above. These loads are transmitted through the tabs on the CAL bottom plate.

The Grid shall be capable of tolerating the reaction forces due to CAL acceleration loading.

Thrust and lateral loads shall be applied simultaneously in all combinations, along with bolt pre-loads, for a particular flight event.

The CAL shall be able to withstand the component-level random vibration levels shown in GEVS Table 2.4-4, with levels corrected for unit mass. (SI/SC IRD 3.2.2.8.4)

The Grid shall be capable of tolerating the reaction forces due to CAL vibration loading.

The CAL shall be able to withstand the acoustic levels shown in GEVS Table D-3.

The CAL shall be capable of normal operation after the application of the external shock levels given in GEVS Table D-8.

The CAL tabs shall be capable of handling compressive bolt pre-loads of TBD per bolt, with no permanent deformation.

The CAL shall be capable of tolerating the structural loads imparted by a distortion of the bolting surface on the Grid as described in TBD, given the stiffness requirements of section TBD, above.

During worst-case deflection of the Grid during launch, the CAL bolting surface shall distort no more than that described in TBD.

Tapped holes for mounting the CAL shall tolerate a maximum load plus pre-load of TBD newtons, without adverse affects on the threads or bolts.

5.3.4 Flatness specification

5.3.5 Drill Template

5.4 Mass Properties

5.4.1 Mass

5.4.2 Center of gravity

5.4.3 Moment of Inertia

5.5 Alignment

5.5.1 Alignment Requirement

5.5.2 Tracking of Mechanical Interface Shifts

5.6 Field Of View (FOV)

5.7 Handling Operations And Lift Points

5.7.1 Handling

5.8 Access

5.8.1 Instrument Access

5.8.2 Spacecraft Access

5.9 Thermal Interface and Heat Transfer

The bolted joint interface with the Grid shall be the primary mechanism for transferring heat into and out of the CAL.

The bolted joint interface with the Grid shall be capable of conducting TBD watts of heat generated by the CAL plus TBD watts of heat conducted through the CAL from the electronics, with a maximum temperature drop across the joint of TBD degC (averaged around the perimeter of the CAL).

The temperature of the CAL side of the thermal interface with the Grid shall stay within the following values.

The CAL shall be capable of operating and surviving within the full range of these temperatures.

The Grid and thermal control system shall be capable of ensuring that actual temperatures stay within these bounds.

State	Tmin	Tmax
Operating	TBD degC	TBD degC
Survival	TBD degC	TBD degC
Ground Ops	TBD degC	TBD degC

The maximum rate of temperature change at the interface shall be 5 degC/hr

The CAL shall have an effective heat capacitance of TBD J/degC at the interface. This drives the dynamic thermal behavior of the LAT.

The bolted joint interface with the CAL back plate shall be the primary mechanism for transferring heat into and out of the electronics modules.

Heat being transferred and max rate of change, interface temp range, effective heat capacitance and conductivity req's of subsystem. Describe load magnitude, method of transfer, direction

The bolted joint interface between the CAL and electronics modules shall be capable of conducting TBD watts of heat generated by the electronics, with a maximum temperature drop across the joint of TBD degC (averaged around the perimeter of the module).

The temperature of the electronics module side of the thermal interface with the CAL shall stay within the following values. The electronics modules shall be capable of operating and surviving within the full range of these temperatures.

State	**Tmin**	**Tmax**
Operating	TBD degC	TBD degC
Survival	TBD degC	TBD degC
Ground Ops	TBD degC	TBD degC

The top of the CAL module and underside of the bottom tray of the TKR module are radiatively coupled. The maximum radiation heat transfer from the CAL to the TKR shall be 2 watts (TBR), for a temperature difference of 10 degC (TBR).

6 TEM and POWER SUPPLY MECHANICAL INTERFACES

6.1 Dimensions

Stay-clear dimensions are not-to-exceed dimensions. The nominal dimensions plus any needed tolerances should be includes within this stay-clear. These dimensions are defined, and will be measured with respect to a unique datum reference system for each module. For Mechanical Systems, the datum reference is defined in TBD.

6.1.1 Nominal Stay-Clear Dimensions

The electronics module mount to the bottom plate of the CAL shall conform to the dimensions and tolerances shown in LAT-TBD. This describes the nominal dimensions and tolerances of the mounting pads and holes on the CAL bottom plate.

6.1.2 Dynamic Stay-Clear for Dynamic Motions

During launch and on-orbit operation, dynamic motions due to external loading may cause parts of the Mechanical Systems to violate the static stay-clear dimensions. Maximum excursions beyond the static stay-clears delineated above are:

Lateral

Vertical

6.2 Mounting Configuration

6.2.1 Interface Location

6.2.2 Structural Mounting and Load Transfer

The Grid mounting surface for the CAL shall conform to the dimensions and tolerances shown in LAT-TBD. This describes the nominal dimensions and tolerances of the mounting surface on the Grid, holes and threaded holes.

The CAL shall be able to carry all loads associated with the electronics box when subjected to the launch environments described in section TBD, above. No further magnification or attenuation of loads is expected.

Tapped holes for mounting the electronics module to the CAL shall tolerate a maximum load plus pre-load of TBD newtons, without adverse affects on the threads or bolts.

6.2.3 Structural Interface Loads

6.3 Alignment

6.3.1 Alignment Requirement

6.3.2 Tracking of Mechanical Interface Shifts

6.4 Handling Operations And Lift Points

6.4.1 Handling

6.5 Access

6.5.1 Instrument Access

6.5.2 Spacecraft Access

6.6 Thermal Interface and Heat Transfer

The bolted joint interface with the CAL back plate shall be the primary mechanism for transferring heat into and out of the electronics modules.

Heat being transferred and max rate of change, interface temp range, effective heat capacitance and conductivity req's of subsystem. Describe load magnitude, method of transfer, direction

The bolted joint interface between the CAL and electronics modules shall be capable of conducting TBD watts of heat generated by the electronics, with a maximum temperature drop across the joint of TBD degC (averaged around the perimeter of the module).

The temperature of the electronics module side of the thermal interface with the CAL shall stay within the following values. The electronics modules shall be capable of operating and surviving within the full range of these temperatures.

State	Tmin	Tmax
Operating	TBD degC	TBD degC
Survival	TBD degC	TBD degC
Ground Ops	TBD degC	TBD degC

The top of the CAL module and underside of the bottom tray of the TKR module are radiatively coupled. The maximum radiation heat transfer from the CAL to the TKR shall be 2 watts (TBR), for a temperature difference of 10 degC (TBR).

7 TRACKER MECHANICAL INTERFACES

CAL baseplate shall provide mechanical support and strain relief for TRACKER electrical cables as they exit the GRID structure and attach to the TEM mounted on the CAL baseplate.

7.1 Dimensions

7.2 Mounting Configuration

7.2.1 Interface Location

7.2.2 Structural Mounting and Load Transfer

7.2.3 Structural Interface Loads

7.3 Alignment

7.3.1 Alignment Requirement

7.3.2 Tracking of Mechanical Interface Shifts

7.4 Handling Operations And Lift Points

7.4.1 Handling

7.5 Access

7.5.1 Instrument Access

7.5.2 Spacecraft Access

8 ELECTRICAL INTERFACES

8.1 Tower Electronics Module (TEM) Interface

8.1.1 Commanding Interface

8.1.2 Command Timing

8.1.3 Data Interface

8.1.4 Data Timing

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8.2.1 Essential Powers

8.2.2 Non-Essential Power B

8.2.3 Non-Essential Power A

8.2.4 Transient Behavior of the Busses

8.2.5 Fault Protection

8.3 Interface Connections And Pin Assignments

8.3.1 Cable Routing and Support

No cables cross the Cal-Grid interface

Kapton flex cables which exit the CAL bottom plate shall be supported off the electronics modules at a strain-relief location, prior to where they are terminated into the module.

8.3.2 Pin assignments

8.3.3 Connectors

8.4 Electromagnetic Compatibility

8.5 Grounding

8.6 Ground Processing & Transportation Environments

9 THERMAL

9.1 Design Responsibility

9.2 Heat Flow Across The Interface

9.3 Integration & Test Thermal Environment

10 INTEGRATION AND TEST INTERFACES

10.1 Integration Stay-Clears and Access Requirements

The CAL module is nominally mounted in the Grid with a Power Supply and TEM attached.
Any CAL module shall be capable of being integrated into any Grid bay in the LAT.

Any CAL module shall be capable of being de-integrated from the Grid at any time after it has been integrated, with no need to remove or loose verification of neighboring modules.

The Grid shall provide a minimum of 0.70 mm (TBR) on all four sides of the CAL module during integration. This space will be used only for integration and alignment allowance. Thus, when the CAL is integrated, the 0.70 mm gap will be used to correct for mis-alignments or tolerances of position location in the mating features.

During CAL integration, there shall be NO access available from the front face of the Grid.

The CAL shall be capable of being integrated vertically, either from underneath the Grid, or being lowered down from above an inverted Grid.

Electronics module mounting on the CAL and testing shall accomplished with the module closed.

10.2 Provision for Alignment and Surveying

During CAL integration, there shall be NO surveying lines-of-sight available from the front face of the Grid.

CAL modules shall not be capable of being aligned after integration on the Grid.

CAL modules shall have reference fiducials on the underside of their bottom plates to allow its position to be surveyed after integration.

10.3 Integration GSE

[mounting and allowed motions during integration]

10.4 Ground Alignment Requirements

CAL module fiducials shall be surveyed to a precision of TBD mm, with respect to the LAT fiducials.

10.5 Environmental Control

11 OTHER INTERFACES

11.1 Venting

During launch, air from a CAL module shall be vented down, past the bottom plate, and not up into the volume between the TKR and CAL.

11.2 Particulates

[Subsystem containment requirements]

The CAL shall contain all fracture-sensitive materials such that any particulates produced by a fracture shall be contained within the stay-clear volume of the CAL.

11.3 Other

[Description of any other stuff that crosses interface, including need to contain any fracture-sensitive items within subsystem]